BENTLY NEVADA® GE Motors & Industrial Systems

Integrated turbine-generator control and online machinery management

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To provide turbine-generator users with better asset management, Bently Nevada Corporation and GE Motors & Industrial Systems have integrated their products to enhance turbine-generator monitoring and diagnostics. This cooperation integrates Bently Nevada's newest online machinery management system, Data Manager® 2000 for Windows NT™, with the GE Speedtronic® Mark V Turbine Control's new human machine interface (HMI) for turbine-generator operation and maintenance. The HMI utilizes GE Fanuc's powerful CIMPLICITY® SCADA Software. This product combination allows plant personnel access to time-tagged data, which can be used to develop a better understanding of the machine's response to process operations and the machine's mechanical condition. Collected data can be analyzed to identify abnormalities in time to take corrective action before conditions develop into costly forced outages.

Integration of vibration, process and other machinery information via a single HMI provides the following benefits:

- It allows time synchronization of vibration and process data, an important tool for determining cause and effect relationships. In addition, machinery conditions which are normal responses to changes in the process can be distinguished from legitimate mechanical problems.
- Operators gain a better understanding of machinery condition because all information relevant to the turbine-generator system is presented using a single HMI. Operator training costs are also reduced with a single system.
- Machinery specialists have access to important steady state and start-up/shutdown vibration data required for effective diagnostics using GE's and Bently Nevada's proven software and methodologies.
- All data and displays (turbine-generator control and machinery management) can be accessed remotely via modem, wide area network or other methods, as allowed by Microsoft Windows NT.

This allows personnel to easily monitor unstaffed facilities and allows specialists data access to diagnose problems remotely.

GE Mark V new human machine interface

The GE Mark V's human machine interface (HMI) is an industrial-grade computer system running the Microsoft Windows NT Operating System,CIMPLICITY SCADA software and specialized turbine software. The CIMPLICITY and turbine display software permits a user to view and adjust machine operating parameters, for example, startup and shutdown. It also provides trending, alarm annunciation and archiving, and balance-of-plant functions useful to operators.

Hardware

Figure 1 shows the system architecture and that the vibration transducer signals are used by both the GE & Bently Nevada systems. Signals going directly to the Speedtronic Mark V control provide highly reliable monitoring

and turbine protection. The signals to the Bently Nevada monitor are pre-processed and passed to the Bently Nevada TDIX Communications Processor.

The TDIX Communications Processor has several important functions:

1. The TDIX provides high-speed parallel sampling of vibration signals, which are processed into static and dynamic data. The data is temporarily stored at fixed time intervals and is known as steady state data collection.

Static and dynamic data

Static data is any characteristic of the vibration that can be represented by a single number or status. Examples include vibration amplitude, filtered vibration phase lag, filtered vibration amplitude, the transducer gap voltage, alarm status, transducer OK status and several other parameters.

Dynamic data is the actual vibration waveform. It is obtained by appropriate sampling of the vibration signals, so the waveform can be faithfully reconstructed and represented in both the time domain (for example, Orbit/timebase plots) and frequency domain (spectrum plots). Dynamic data cannot be characterized by a single number.

2. When a machine startup or shutdown is detected, the TDIX will change its sampling mode, so data is collected at precise rpm intervals. This is known as startup/shutdown data collection. Turbomachinery can accelerate or decelerate very quickly. Thus, the ability to sample and analyze data at various rpms is extremely important for a complete understanding of machinery behavior. An example of the machinery information available using this technique is the ability to determine rotor and machine support structure resonances.

3. When an alarm occurs in the Bently Nevada Monitoring System, the TDIX will store the dynamic and static data present at the moment of alarm. This allows the user to obtain a "snapshot" of the machine conditions at the instant the alarm occurred. This is a powerful tool for determining the root cause of an alarm, such as a machine rub, a sudden or gradual change in rotor balance or process conditions.

The unique design of TDIX ensures that "real world" situations do not result in lost data. One example might be a sudden change in the mechanical conditions leading to an unplanned machine trip. The TDIX will collect the data leading up to the alarm, the data at the moment of trip, and all necessary shutdown data as the machine coasts down. It can even automatically capture the startup data on the subsequent restart attempt without overwriting the previously-gathered data.

The system is also highly useful during planned startups and shutdowns to confirm the machine dynamics are normal. It then continues monitoring the condition between service intervals. The vibration history will be one element contributing to condition-based maintenance, which is intended to increase mission times (time between outages) without compromising performance.

Software

At the heart of this integrated turbine-generator control and online machinery management is software. For GE, this is the new HMI which uses GE's CIMPLICITY SCADA Software. For Bently Nevada, this is the Data Manager 2000 for Windows NT Software. The Microsoft Windows NT operating system is used by both software packages.

The Data Manager 2000 server is a data acquisition computer that can operate without a keyboard, screen or pointing device. Its function is to acquire data from the TDIX and then build and maintain a permanent database. This database is readable by a Data Manager 2000 "client" computer, running Data Manager 2000 Display Software. The display software provides a full range of steady-state and startup/shutdown plots necessary for proper machinery diagnostics. Examples of these plot types include orbit/timebase, polar, Bode, spectrum, shaft centerline and others.

Information for Operators

The static data collected by the Data Manager 2000 server is sent to the HMI server over the Ethernet Data Highway. When it is in the HMI server, this "real time" static machine condition data is time-stamped and integrated with the data from the Mark V into a common database. This integrated database is the key to operator displays that present all data on a single operator interface and provide time synchronized process and machine condition data on the same screen.

Information for Machinery Specialists

To address the unique needs of rotating machinery specialists, additional data archival and display capabilities are required in addition to the HMI static data. This is where Bently Nevada's Data Manager 2000 Software is used. Turbine and process data from the Mark V is passed from the HMI to the Data Manager 2000 server. This creates a second database of integrated vibration and turbine data that is suitable for machinery specialists. Unlike the HMI database, which includes only static machine condition data, the Data Manger 2000 database also includes dynamic data. This "integrated" database is used to create Data Manager 2000 displays, reports and plots.

Since both Data Manager 2000 and CIMPLICITY operate under Windows NT, a copy of Data Manager client software can be used on the HMI server. This allows the machinery specialist to view data at the same terminal as he uses for turbine operation and maintenance. Multiple windows can be opened to view static and dynamic data simultaneously.

Synchronizing vibration data with turbine-generator data is accomplished by using an IRIG-B time signal from the Mark V control system as an input to the Data Manager 2000 server. This assures that the time tags applied by the Data Manager 2000 server are synchronized with time tags applied by the Mark V control system.

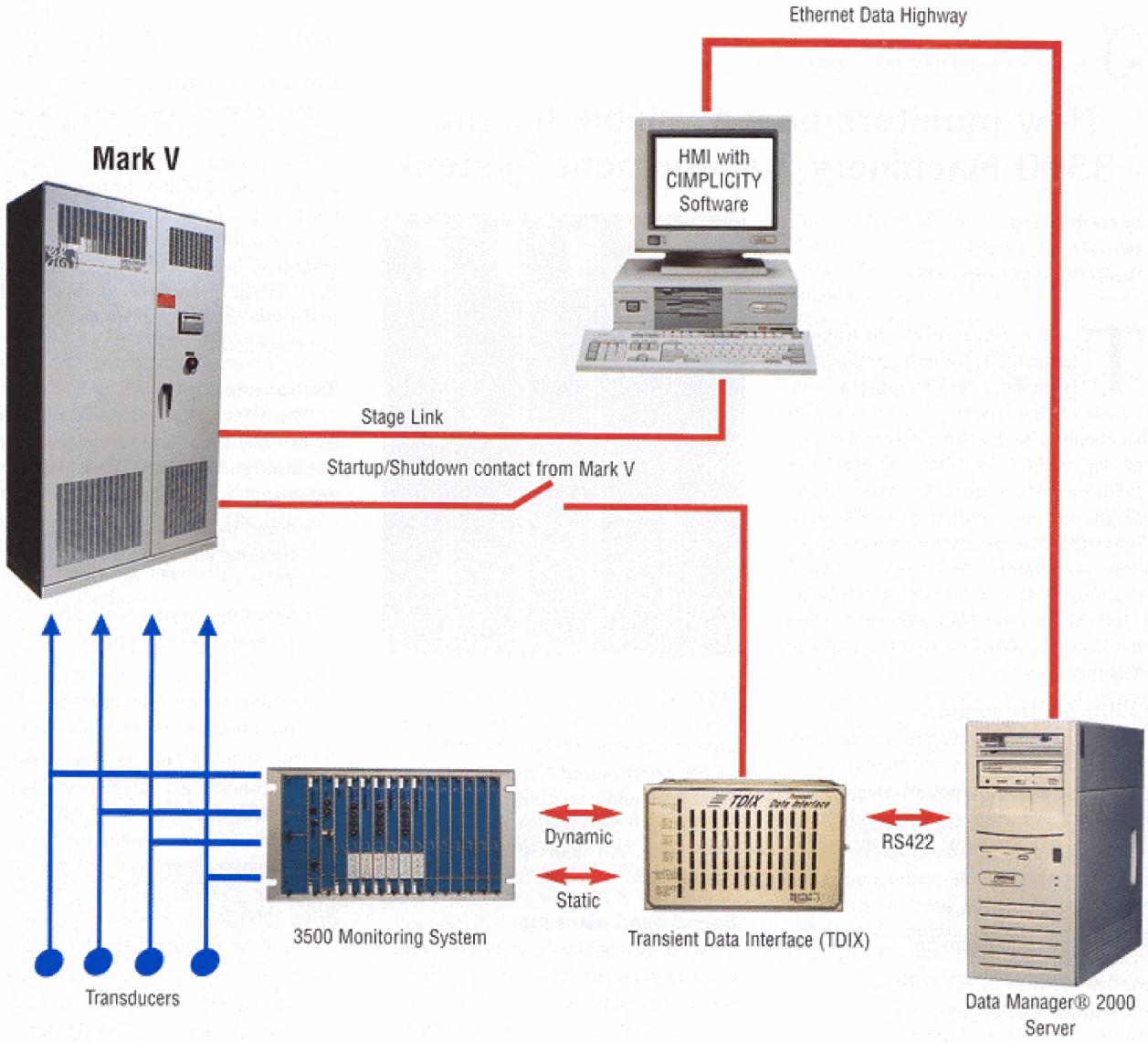

Figure1
Integrated machinery management architecture

Retrofit considerations

For retrofit applications, special care has been taken to ensure the system can generally use existing Bently Nevada transducers and monitors. In addition to the transducers and monitors, Data Manager 2000 Software and at least one TDIX Communications Processor are required. Similarly, the system requires the use of the Speedtronic Mark V controls. Depending on the site configuration, at least one HMI using CIMPLICITY must be used.

While most Bently Nevada transducers and certain non-Bently Nevada transducers are compatible, a site audit is strongly recommended to ensure compatibility with existing equipment. Compatible monitors types include the Bently Nevada 9000, 7200, 3300 and 3500 monitors. For proper machinery diagnostics, a minimum of XY probes at each radial bearing, dual axial probes at each thrust bearing and appropriate Keyphasor® transducers for each shaft are recommended. ■